Remarks/Arguments:

Claims 1, 3-7, 12-17, 19 and 22 have been amended. No new matter is introduced herein. Claim 2 has been cancelled without prejudice. Of pending claims 1 and 3-29, claims 23-28 have been withdrawn.

Claim 1 has been amended to clarify that: 1) the first member has a refractive index distribution which decreases with distance from an optical axis extending through the photonic crystal, 2) the refractive index distribution decreases along a first direction perpendicular to the optical axis and 3) the photonic crystal includes a plurality of second members placed within the first member along a second direction of the photonic crystal. No new matter is introduced herein. Basis for the amendment can be found, for example, at paragraph [0053]; paragraphs [0064-0067] and Figs. 1 and 2 of the original specification. Claim 2 has been cancelled. Claims 3-7, 12-17, 19 and 22 have been amended to clarify the language and to correspond with claim 1. Claim 3 has been amended to depend from claim 1. Claim 15 has been amended to depend from claim 9.

Claim 1 has been objected to as being unclear. Claim 1 has been amended accordingly. Applicant respectfully requests that the objection to claim 1 be withdrawn.

Claim 15 has been objected to as being unclear. In particular, the Examiner asserts that the feature the "predetermined location" is unclear. Claim 15 has been amended to depend from claim 9 and to clarify that the photonic crystal includes a predetermined location extending from the light incident end to a light outgoing end which has no second member. Accordingly, Applicant respectfully requests that the objection to claim 15 be withdrawn.

At paragraph 6, page 3 of the Office Action, the Examiner suggests amending claims 2-22 and 29 to clarify the language. Applicant has cancelled claim 2 and has amended claims 3-7, 12-17, 19 and 22 accordingly.

Claims 2-22 and 29 have been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Claim 2 has been cancelled. Claims 3-7, 12-17, 19

and 22 have been amended to clarify the language. Accordingly, Applicant respectfully requests that the rejection of claims 3-22 and 29 under 35 U.S.C. § 112, second paragraph be withdrawn.

Claims 1 and 2 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Hamada (JP 2003-240989). Claims 1 and 2 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Flory et al. (JP 2002-365599). Claims 1 and 2 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Charlton et al. ("*Guided Mode Analysis, and Fabrication of a 2-Dimensional Visible Photonic Band Structure Confined Within A Planer Semiconductor Waveguide*," Materials Science & Engineering B49, 1997, pp. 155-165). Claims 1 and 2 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Johnson et al. ("*Guided Modes in Photonic Crystal Slabs*," Physical Review B, Vol. 60, No. 8, August 15, 1999, pp. 5751-5758). Claims 1 and 2 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Weisbuch et al. ("*3D Control of Light in Waveguide-Based Two-Dimensional Photonic Crystals*," IEICE Trans. Electron., Vol. E84-C, No. 5, May, 2001, pp. 660-668). Claims 1 and 2 have been rejected under 35 U.S.C. § 102(e) as being anticipated by Parker et al. (US 2004/0067035). Claims 1 and 2 have been rejected under 35 U.S.C. § 102(e) as being anticipated by Zoorob et al. (US 2004/0086244). Claims 1 and 2 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Yokohama et al. (JP 2001-337236). Claim 2 has been cancelled. It is respectfully submitted, however, that claim 1 is patentable over the cited art for the reasons set forth below.

Claim 1 includes features neither disclosed nor suggested by the cited art, namely:

> ... a first member having a <u>refractive index distribution which decreases with distance from an optical axis</u> extending through the photonic crystal, the refractive index distribution <u>decreasing along a first direction perpendicular to the optical axis</u>; ... (Emphasis Added)

Referring to Applicant's Figs. 1 and 2, Applicant's claim 1 relates to an optical device which includes a photonic crystal 4 having a first member 1. First member 1

has a refractive index distribution 12 which decreases with distance from optical axis 20. As shown in Figs. 1 and 2, the refractive index distribution decreases along a first direction (for example, the Y-axis) which is perpendicular to optical axis 20. Photonic crystal 4 also includes a plurality of second members 2 which are substantially periodically placed within the first member along a second direction (for example, the X-axis).

Hamada discloses, in Fig. 11, a photonic crystal having a slab waveguide 18. Waveguide 18 includes thin film core 9 and cladding substrate 145. (Abstract and paragraph [0055] of a machine translation). Waveguide 18 includes hole 45 which penetrates thin film core 9 (Fig. 11) or which may penetrate cladding section 81 (Fig. 8). (Paragraph [0143]). Figs. 9(a) and 9(b) show a method of forming a periodic structure in polymer thin film 91 using mask 92 and ion beam 95. (Paragraphs [0008-0010]). Figs. 15(a)-15(d) relate to a method of producing a substrate 1501 having portions 1503 with a different refractive index material 1505. (Paragraph [0127]).

Flory et al. disclose, in Fig. 9(a), a photonic crystal structure 60 including photonic crystal column part 62 formed between cladding layers 64, 65. In Fig. 9(b), photonic crystal column part 62 is provided with only a lower cladding layer 66. (Paragraph [0035] of a machine translation).

Charlton et al. relate to a graphical method for calculating guided Bloch modes supported by a two-dimensional photonic lattice etched into a planar waveguide structure (Abstract). Charlton et al. teach fabrication of a waveguiding photonic crystal having a polarization dependent optical band gap. The structure includes an array of air pores arranged on a triangular lattice etched through core and cladding layers of a single mode silicon nitride waveguide. (Page 156, left column, lines 37-50 and page 162, right column, lines 16-29). Charlton et al. also teach that the effective index of the core is greater than the index of the cladding and buffer layers, in order to confine light within the photonic lattice. (Page 160, right column, lines 13-23).

Johnson et al. relate to photonic crystal slabs. (Abstract and introduction). As

As shown in Fig. 3(b), a photonic crystal slab includes a triangular lattice of holes, where the slab is suspended in air. (Page 5752, right column). In Figs. 8(a) and 8(b), rod slabs and whole slabs are sandwiched between material having a uniform dielectric constant.

Weisbuch et al. relate to two-dimensional (2D) photonic crystals etched through waveguide supported by substrates. (Summary). Weisbuch et al. teach forming III-V semiconductor-based photonic crystals where vertical confinement is provided by a heterostructure waveguide and where in-plane propagation control is provided by 2D photonic crystal elements. (Page 661, right column and page 666, (Conclusion). Fig. 8 relates to system for in-plane propagation, with dielectric plugs in the air-holes illustrating a real system. A difference in the dielectric constant represents a dielectric core-cladding contrast of the waveguide. (Page 664, left column). Fig. 14(a) represents coupled hexagonal cavities etched in a waveguide heterostructure.

Parker et al. disclose, in Fig. 1, a photonic crystal waveguide structure including core 1, cladding 2 and buffer 3. The structure includes a photonic crystal region having air rods 4. (Paragraph [0052-0053]). Fig. 2 shows another waveguide structure which includes an array of rods 11 having a refractive index that is greater than the refractive index of core 10. (Paragraph [0054]). Fig. 3 shows a further waveguide design including buffer 23, core layer 20, rods 21 and cladding layer 22. (Paragraph [0060]). Fig. 5 shows an optical fiber which incorporates a waveguide structure. The waveguide structure includes an array of filled holes 41 incorporated through cladding 42 and core 43. (Paragraph [0065]).

Zoorob et al. disclose, in Fig. 1, a photonic crystal including core layer 1, cladding layer 2 and buffer layer 3. The photonic crystal region includes air rods 4. (Paragraph [0034]). Zoorob et al. disclose, in Figs. 2a-2c, a waveguide structure including core layer 10, array of rods 11 in core layer 10, buffer layer 12 and cladding layer 13, where the refractive indices of core layer 10, rods 11, cladding layer 13 and buffer layer 12 are different. (Paragraph [0036-0038]).

Yokohama et al. disclose, in Fig. 1, a photonic crystal including substrate 1, lower clad layer 2, light guide layer 3, 4 and upper clad layer 5. The light guide layer includes a plurality of columnar parts 4 and part 3 having a refractive index different from part 4. The refractive index of clad layers 2, 5 is lower than the refractive index of light guide layer 3, 4. (Abstract). Figs. 7, 8 and 12 relate to photonic crystals including a defect (paragraphs [0011], [0040] and [0046] of a machine translation).

None of the cited art, however, disclose or suggest a photonic crystal including a first member having a <u>refractive index distribution which decreases with distance from an optical axis</u> along a first direction <u>perpendicular to</u> the optical axis, as required by claim 1 (emphasis added). Hamada only relates to a photonic crystal slab waveguide having holes periodically arrayed in at least a thin film core. Flory et al. only teach photonic crystal columns supported by at least one cladding layer. Charlton et al. only teach a photonic crystal structure having core and cladding layers, where the refractive index of the core layer is greater than the refractive index of the cladding layer. Johnson et al. only teach photonic crystal slabs with holes periodically arrayed in the slab. Weisbuch et al. only teach forming photonic crystals in a heterostructure waveguide. Parker et al. only teach an optical waveguide with a photonic crystal region, where the waveguide has different refractive indices for the core layer and the cladding layer. Zoorob et al. only teach waveguides with a photonic crystal region, where the waveguide has different refractive indices for the core layer and the cladding layer. Yokohama et al. only teach a photonic crystal including a light guide layer and surrounding clad layers, where the light guide layer has a higher refractive index than the cladding layers. Thus, the cited art of record do not include all of the features of claim 1.

Because none of the cited art disclose or suggest all of the features of claim 1, claim 1 is patentable over the cited art. Accordingly, allowance of claim 1 is respectfully requested.

Claims 3-22 and 29 include all of the features of claim 1 from which they depend and are patentable over the cited art for at least the same reasons as claim 1.

In view of the amendments and arguments set forth above, the above-identified application is in condition for allowance, which action is respectfully requested.

Respectfully submitted,

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